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22 Nov

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[redacted]

Requi... Settlement ... written - 29 Nov
ENG-M61-848

In reply refer to:

14 November 1961

...ATORIES INC.
DISTRIBUTION

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[redacted]

(1) RED
OC-E
LAB (Return)
SCHEMATIC ATT.
(1) OC-T @ Schematic
~~No Schematic Att.~~
(1) CONTRACT FILE

Subject: AUTOMATIC GAIN REGULATOR SYSTEM
FINAL REPORT

Gentlemen:

I. OBJECTIVE OF THIS PROGRAM

The objective of this program was to design and develop an automatic gain control system (subsequently referred to as AGR) for audio, which would produce a useable output level under varying ambient noise conditions. The target specifications for the unit are as follows:

1. Power input - up to 1 mw.

2. Maximum power output - 100 μw into a 2,000 ohm load.

3. Output in the absence of noise - 1 to 2 microwatts with a maximum Automatic Gain Regulation of 17 to 20 db, providing an automatic control of at least 2 to 100 microwatts under noise conditions varying from 0 to maximum.

4. Intelligibility - The Automatic Gain Regulation System will not appreciably alter intelligibility for signal levels which would normally be understandable.

5. Size - This unit will have a volume of approximately one-half to 1 cubic inch and will have a flat form factor.

6. Power Source - Operating power of the Automatic Gain Regulation Device should be derived from a small nickel cadmium storage cell which would receive charging energy by rectification of the audio input to this device.

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II. MEETINGS

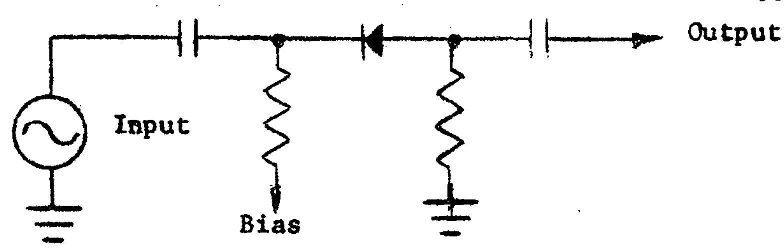
A meeting was held at [redacted], Philadelphia, midway through the project. At 25X1 this time, an operational breadboard was demonstrated.

III. WORK PERFORMED

a) A breadboard was built up based on an [redacted] developed system of audio gai 25X1 regulation. This system was tested and improved during the first month of the project. At the same time, other systems and methods were investigated, many of which were breadboarded and tested. None met the requirements of simplicity, attenuation range, or reliability as well as did the diode AGR system.

b) Description of the Diode Attenuator

The AGR utilizes diode conduction characteristics to obtain a variable impedance. Generally, voltage controlled attenuation circuits utilizing diode networks take advantage of the change in the resistance of diodes in the reverse bias direction. This method is unsatisfactory when used in conjunction with certain low impedance semi-conductor circuitry. The method described here is one utilizing the change in resistance of diode when it is based in the forward direction. As one examines closely the curve of forward current versus diode resistance, it is apparent that at the extreme low end of this curve there is a useable portion of variable resistance. The impedance levels associated with this device are considerably low, therefore making it compatible with other low impedance circuitry. In practice, this is a very low-level device, due to the very non-linear forward characteristic of the diode in the low bias region. The signal to be attenuated must be a very small percentage of the total diode charge. This limitation, however, allows a very large ratio of attenuation for a simple network. In practice, it has been found that voltage ratios of as much as 200 to 1 are possible, provided the correct type of diode is used. A typical circuit is shown below:



IV. THEORY OPERATION (Refer to Block Diagram - Figure 1)

The audio source delivers 1 mw maximum power to a pre-attenuator (Pre-attenuation is necessary to bring the signal into the linear forward characteristic of the diode, as described above.) The signal is then amplified in the output

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stage so that 200 µw may be delivered to the load. The signal from the microphone feeds a high-gain noise amplifier, whose output is rectified by a noise rectifier. This signal is filtered to provide the AGR voltage which then is applied to the voltage controlled attenuator.

V. ADDITIONAL CONSIDERATIONS

1. It was originally proposed to supply 100 µw of power to the load but after further investigations and tests, it was found that in some cases under very high ambient noise conditions, more power was necessary. Therefore, the maximum power output was made to be 200 µw or greater. ..

2. It was found that 20 db of control was adequate, as originally proposed, in order to overcome ambient noise changes.

3. The charge time of the system is coincidental with an incoming ambient noise signal. The discharge time constant has been selected to be generally in the area of .25 seconds. Due to the nature of the filter system, discharge time becomes longer with a larger amplitude noise input.

4. It was originally planned to charge the battery, from the signal, but investigation proved this to be impossible. There is not enough current developed from the signal to charge the battery. Example:

> The signal power of 1 mw @ 2KΩ provides 1.4 v rms and a maximum current of 700 µa.

The battery needs minimum 2 ma to charge and at least 1.5 volts to provide the end battery voltage. Adding the unit drain of nominally 4-5 ma, this means that 6-7 ma must be available to charge the battery. As can be seen above, only 700 µa is available from the signal. Because of this, it was agreed to supply power for the unit from an external 12 volt source. Three (3) volt supply was chosen using a zener diode.

VI. FINAL SPECIFICATIONS

The specifications met by the prototype are as follows:

1. Power input - up to 1 mw using a source impedance of 2K ohms.

2. Maximum power output - 200 µw into a 2000Ω load (original specification was 100 µw but this was found to be inadequate under high ambient noise conditions.

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3. Range of gain regulation - nominal regulation of 20 db (2 to 200 μw).

4. Intelligibility - The AGR system does not appreciably alter intelligibility at any signal level.

5. The unit occupies a volume of less than 1 cubic inch. The unit derives power from an external 12 volt source (Negative).

Very truly yours,

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SIGNED

APPROVED

MRK/ld

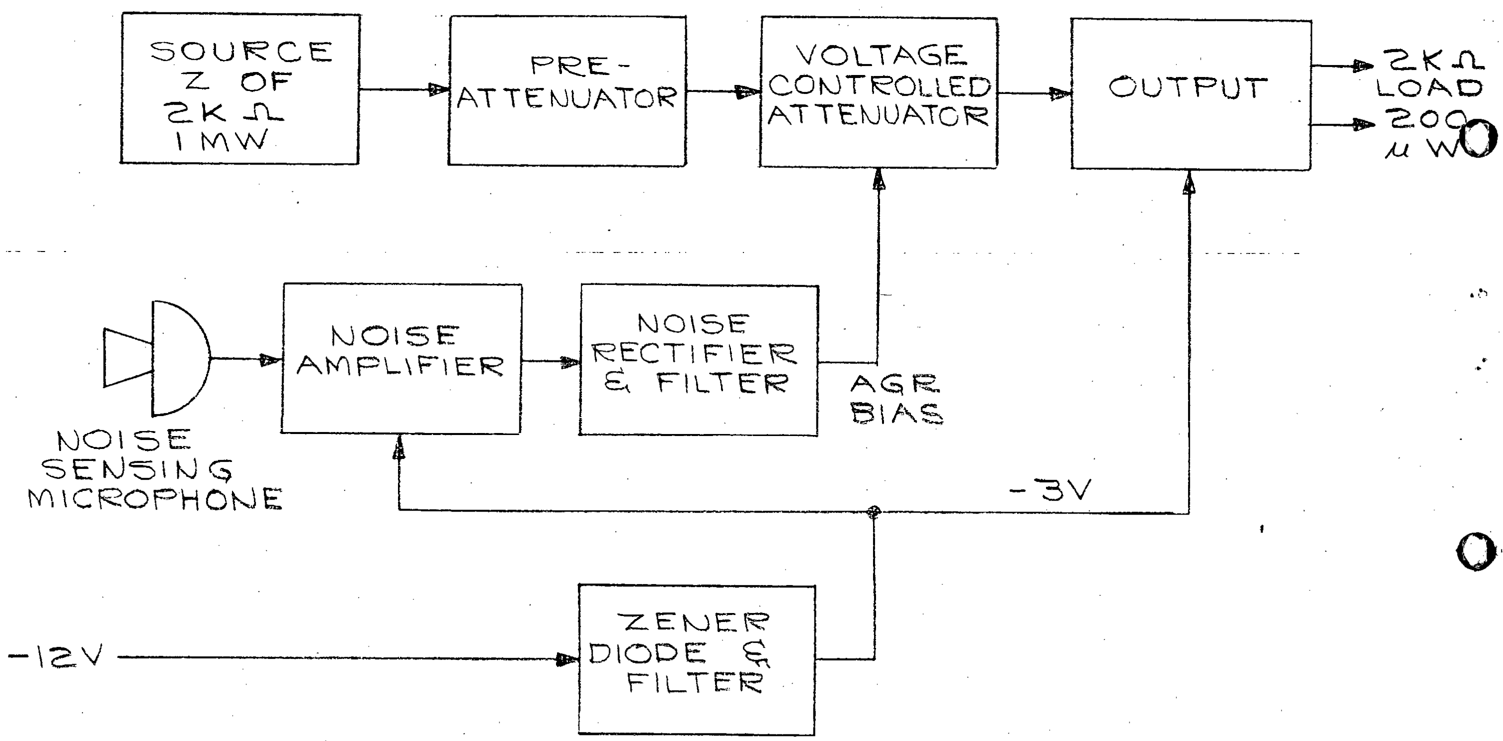
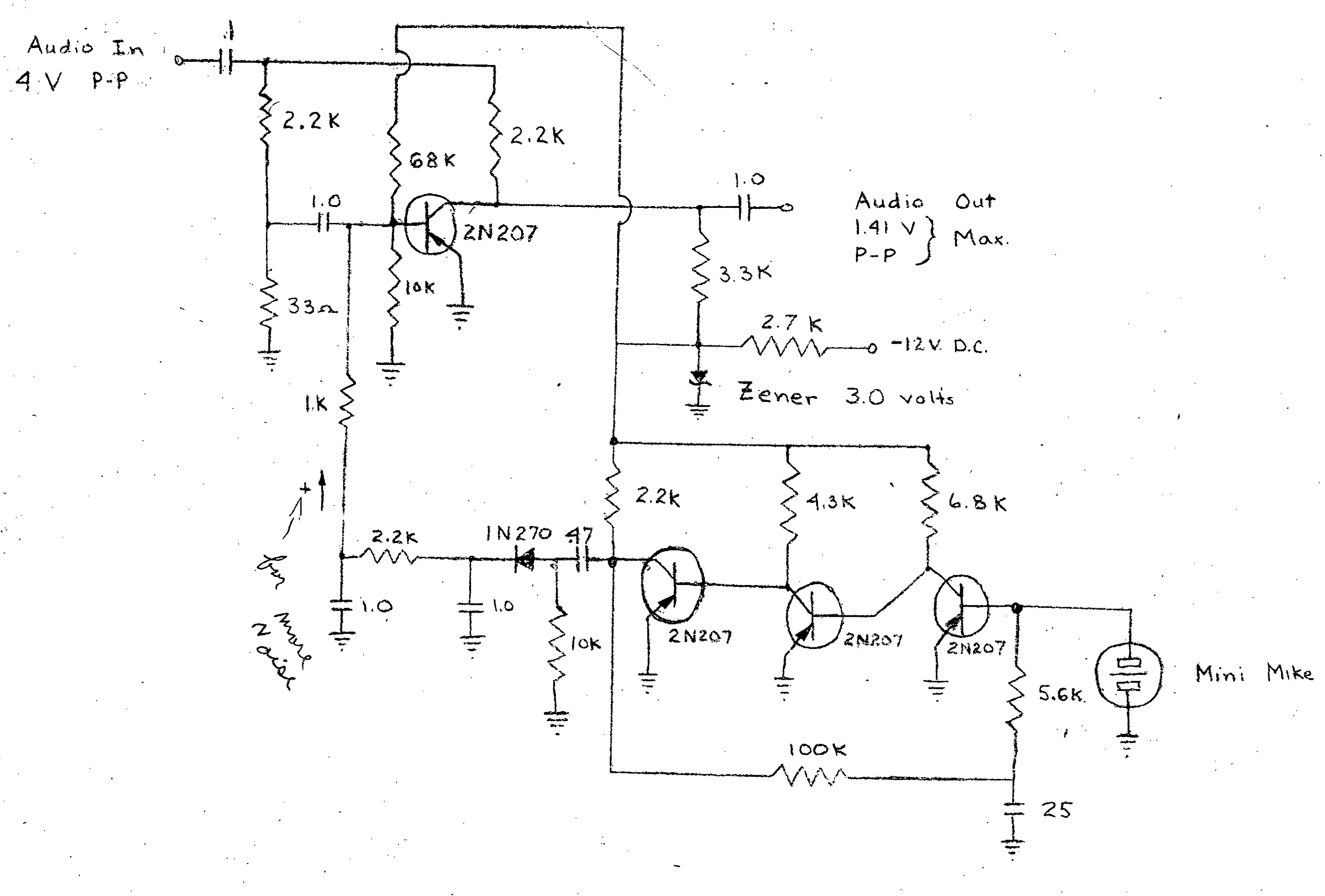


FIGURE 1
BLOCK DIAGRAM OF THE AUTOMATIC GAIN REGULATION SYSTEM



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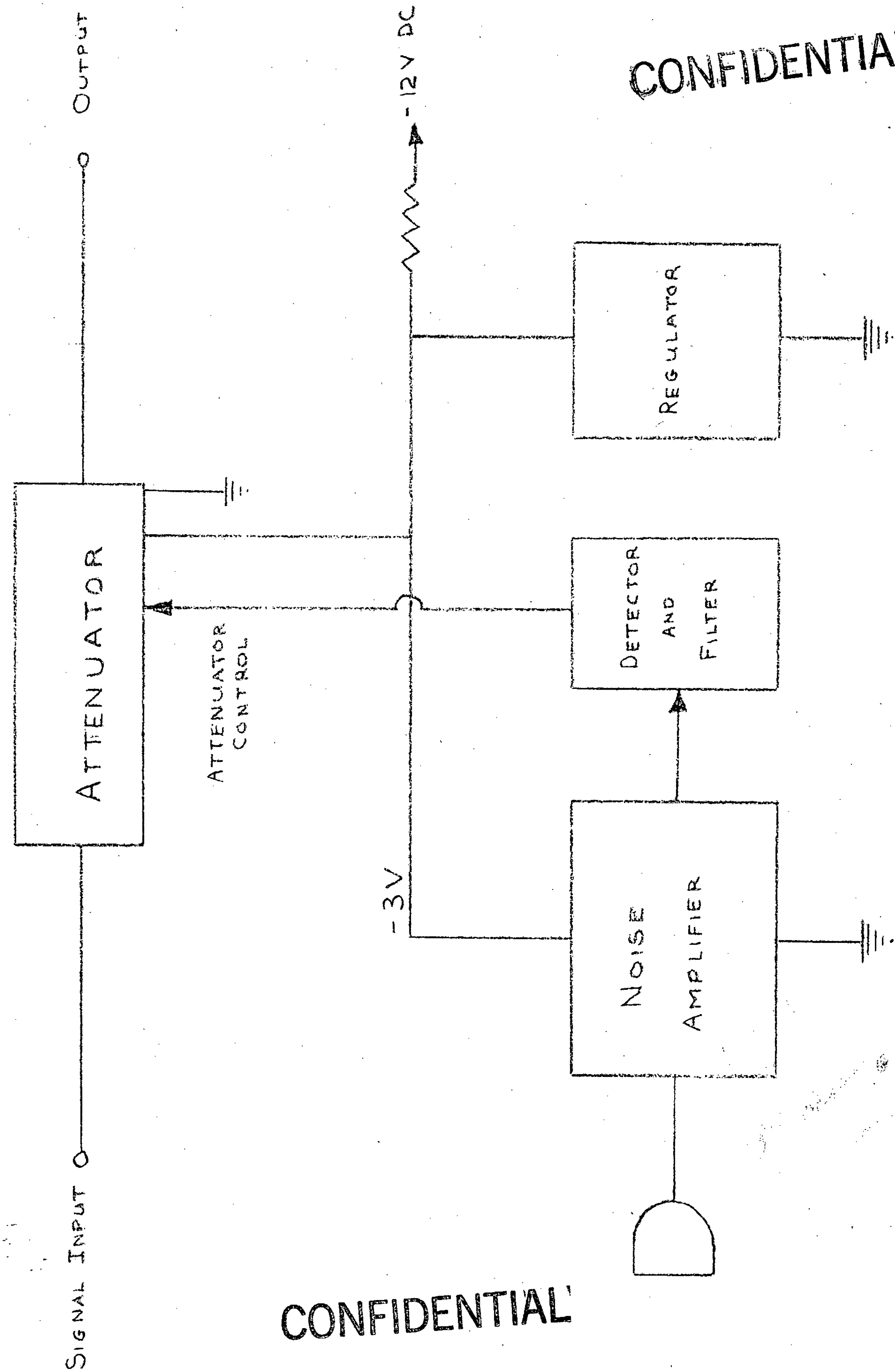

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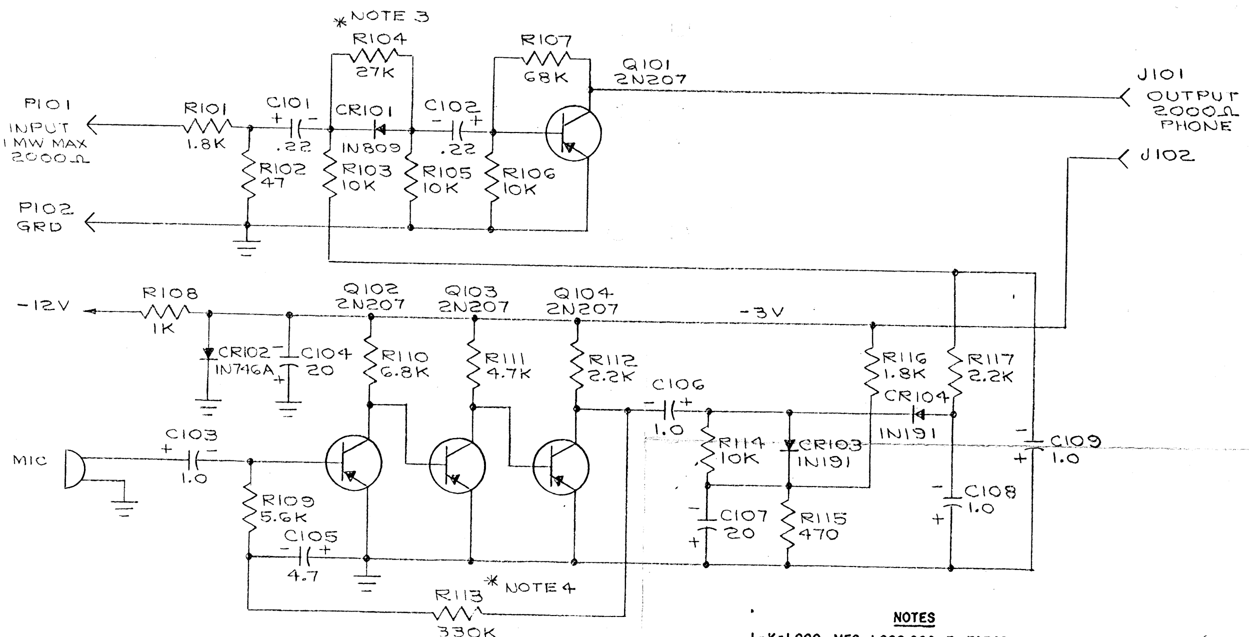
ZONE	REV.	REVISION DESCRIPTIONS	DATE	APPROVAL



NOTES

1 - K = 1,000 MEG = 1,000,000 F = FARAD H = HENRY
M = MILLI S = SECOND U = MICRO W = WATT
2 - UNLESS OTHERWISE INDICATED:
ALL RESISTANCE VALUES ARE IN OHMS.
ALL CAPACITANCE VALUES ARE IN UF.
3 - VALUE SELECTED FOR MINIMUM OUTPUT REQUIRED.
4 - VALUE SELECTED FOR MAX AGR BIAS ON AMBIENT NOISE.

REQ'D. 504	REQ'D. 503	REQ'D. 502	REQ'D. 501	ITEM OR SYMBOL	PART NUMBER	DESCRIPTION
						LIST OF MATERIAL

CLASSIFICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

BASIC DIMENSIONS	2 PLACE DECIMALS	3 PLACE DECIMALS
UP TO 6	±.02	±.005
ABOVE 6 TO 24	±.03	±.010
ABOVE 24	±.06	±.015

ANGULAR DIMENSIONS ±½°

FOR MFG. SPEC. SEE DWG.

ALL EXTERNAL THREADS TO BE CLASS 2A BEFORE PLATING AND CLASS 2 AFTER PLATING. ALL INTERNAL THREADS TO BE CLASS 2B, UNLESS OTHERWISE SPECIFIED.

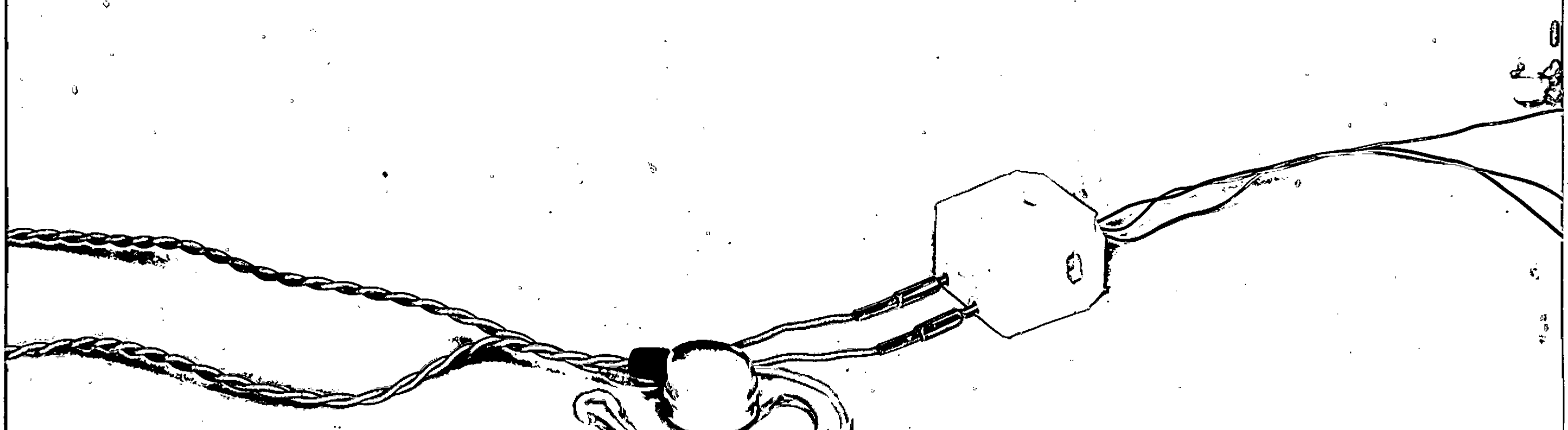
GROUP OR PART	NEXT ASS'Y.	USED ON	NEXT ASS'Y.	FINAL ASS'Y.
	APPLICATION		QTY. REQ'D.	

DATE 11/10/61
CHECKER
APPR.

TITLE
SCHEMATIC DIAGRAM
AUDIO REGULATOR

DWG SIZE C
DWG. NO. 3000368
SCALE
WT.
SHEET
REV.
3000368

6103700



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